NUCLEAR ENERGY RESEARCH INITIATIVE

Radiation Stability of Candidate Materials for Advanced Fuel Cycles

PI: Todd Allen and James Blanchard,
University of Wisconsin

Collaborators: None

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Program Area: Advanced Fuel Cycle Initiative

Project Description

Three types of advanced fuel play important roles in the Advanced Fuel Cycle Initiative (AFCI): inert matrix fuels (IMF) for reducing actinide inventories using light water reactors, coated particle fuels such as the TRISO fuel design being pursued for the very high temperature gas-cooled reactor, and ceramic-ceramic composites being pursued for the gas-cooled fast reactor. These candidate matrix materials are currently being irradiated in the Advanced Test Reactor and are slated for irradiation in the PHENIX fast test reactor. However, the limited neutron exposure and irradiation temperatures will be insufficient to fully characterize the microstructural stability.

This project will use proton irradiation to characterize the microstructural stability of ceramics being considered as matrix material for the advanced fuels. It includes a number of specific objectives. The researchers will determine the radiation stability of candidate materials in response to proton irradiation at temperatures between 600-900°C to understand the effect of radiation on lattice stability, phase change, void growth, and other microstructural features, along with the effect on hardness and fracture toughness. They will perform structural analysis to determine limiting performance, identify promising candidate materials, and determine the effect of radiation on the corrosion stability of inert matrix materials in LWR water. Numerous different materials will be included in the test plan.

Workscope

The following tasks comprise the main elements of this project:

- Final selection of carbide, nitride, and IMF matrix materials to form basis of experimental program, coordinated with AFCI program neutron irradiations.
- Characterize unirradiated microstructures using optical microscopy, SEM, XRD, and TEM
- Measure crack growth in unirradiated materials following Vicker's indentation
- Irradiate samples at temperatures between 600°C and 900°C to 3 dpa and analyze material properties to estimate change in fracture toughness